Satellite Digital Multimedia Broadcast (SDMB) Access Layer Definition

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ABSTRACT

The Satellite Digital Multimedia Broadcast (SDMB) system implements a satellite based broadcast layer to complement the 3G terrestrial mobile cellular networks with broadcast and multicast capabilities for the spectrum-efficient delivery of multimedia services on mobile devices. This paper provides the definition of the SDMB access scheme, addressing its requirements and constraints, the functionality of the individual protocol layers/sub-layers as well as the procedures executed in the SDMB radio access network.

INTRODUCTION

The provision of mobile multimedia services in broadcast and multicast mode is gaining importance in terrestrial mobile networks with the standardization work currently ongoing within the 3GPP Multimedia Broadcast Multicast Services (MBMS) [1] framework. To increase their content delivery capacity, a hybrid mobile satellite broadcast system, also known as the Satellite Digital Multimedia Broadcast (SDMB) system [2][3], has been defined to complement the third generation (3G) terrestrial mobile cellular networks so as to ensure the success of 3G point-to-multipoint (p-t-m) multimedia services. The SDMB system relies on the smart concept of combining high power geostationary satellites and terrestrial repeaters/gap-fillers with nationwide umbrella cells to provide outdoor and in-building coverage. The fundamental objective in the system design is to accommodate 3G standardised handsets with negligible impact on the terminal size and cost in order to maximise market penetration.

This paper focuses on the definition of the SDMB access scheme, both in terms of procedures and individual layer/sub-layer functionality, as part of the ongoing work carried out within the IST MAESTRO (Mobile Applications & sErvices based on Satellite and Terrestrial inteRwOrking) integrated project [4] under the EU Framework Program 6. The access scheme draws heavily from the Universal Terrestrial Radio Access (UTRA) Frequency Division Duplex (FDD) scheme deployed in Terrestrial UMTS (T-UMTS), also known as Wideband Code Division Multiple Access (WCDMA). In fact, the SDMB access scheme has maximum commonality with the WCDMA radio interface in an attempt to achieve maximum reuse of software and hardware on the network side and, most importantly, at the terminal side. Nevertheless, the unique nature of the baseline architecture adopted in the SDMB system, i.e., the absence of a satellite return link[1], poses new limitations and requirements on the design of the access scheme. As such, the access layer defined for the SDMB system will perform only a subset of the functionalities and procedures that are currently standardized within the MBMS framework. In all cases, the 3GPP specifications have been the starting point for the SDMB access scheme definition, and where applicable, adaptations and modifications to suit the satellite environment have been made. Due to this close synergy with the MBMS framework, note that throughout this paper, the terms 'MBMS' and 'SDMB' are used interchangeably, namely whenever the term 'MBMS' is used when describing the SDMB system, its usage within the SDMB context is being referred to.

The paper first lists the requirements for the support of the SDMB services over the satellite radio interface. These are derived from the requirements defined for MBMS, which are filtered in the context of SDMB-specific considerations and architectural constraints. The paper then describes the layers 2 and 3 of the SDMB radio interface, comprising the Medium Access Control (MAC), the Radio Link Control (RLC), the Packet Data Convergence Protocol (PDCP), and

[1] A direct satellite return link is, however, envisaged for the future evolution of SDMB systems in areas where terrestrial coverage is not available, and to provide services related to public protection and crisis management (distress calls, search & rescue) [15].

the Radio Resource Control (RRC) sub-layers. The description of the MBMS procedures involved — notification, radio bearer establishment and data transfer — for the delivery of the SDMB services within the SDMB radio access network (RAN) follows, before we conclude our paper with a summary of the main features of the SDMB access scheme.

ACCESS SCHEME REQUIREMENTS AND CONSTRAINTS

The requirements of the SDMB RAN for the support of MBMS have been derived based on the 3GPP MBMS framework, SDMB specific requirements as well as user service requirements.

Requirements Inherited from 3GPP MBMS Framework

The following requirements have been identified based on [5]:

- SDMB data transfer shall be downlink only.
- Only the MBMS Broadcast mode shall be supported at the SDMB RAN level with four subsequent procedures: session start, MBMS notification, data transfer and session stop. The functions performed by the SDMB RAN are basically the same as those performed by the terrestrial RAN for the support of MBMS broadcast services. The support of multicast services and the relevant procedures such as subscription are part of upper layers (network and application), whereas MBMS multicast mode procedures such as UE join or counting are not relevant to the SDMB RAN.
- During SDMB data transmission, it shall be possible to receive signalling messages via both the satellite (for e.g. MBMS notification) and terrestrial networks (for e.g. user dedicated paging).
- Simultaneous reception of SDMB and non-SDMB services shall depend upon UE capabilities.
- Simultaneous reception of more than one SDMB service shall depend upon UE capabilities.
- A notification procedure shall be used to indicate the start of SDMB data transmission. This procedure shall contain MBMS Radio Bearer information.
- The SDMB UE broadcast subscription and SDMB charging (i.e. end-user charging) should be transparent to the SDMB RAN.
- Reception of the SDMB signal is not guaranteed at SDMB RAN level. The SDMB system does not support individual retransmissions at the radio link layer, nor does it support retransmissions based on feedback from individual subscribers at the radio level. This does not preclude the periodic repetitions of the SDMB content based on operator or content provider scheduling or retransmissions based on feedback at the application level.
- No specific mechanisms in SDMB RAN for the communication of per-UE feedback on the achieved QoS (e.g. link quality measurements) to the SDMB RAN are required.
- UE controlled “service based” cell/spot selection/reselection shall not be permitted.
- Guaranteed ‘QoS’ linked to a certain initial downlink power setting is not required.
- Adopted solutions for enhancing the SDMB signal reception should minimise the impact on the physical layer and maximise reuse of existing physical layer and other MBMS RAN functionality.
- SDMB should allow for low UE power consumption.
- Header compression should be used.
- No specific mechanism aiming at minimizing data loss during spot change (e.g. spot handover) is required.
- Replication of SDMB data streams at SDMB RAN level is not required. The working assumption is to have a mono-spot/cell architecture.

SDMB Specific Requirements

In supporting the dual-mode operation of the terminals, the specific SDMB activities should not impact the terrestrial RAN procedures performed by the UE. All the constraints defined in the 3GPP technical specifications shall be respected even if they have negative impact on the SDMB signal reception, leading to loss of SDMB data. In other words, the terminal shall listen to the terrestrial network intermittently to perform measurements and receive calls, whereby the terrestrial cellular network has pre-emptive priority over the SDMB system. The UE behaviour will be as if it camps over two cells, the basic UMTS/GPRS cell and the complementary SDMB spot. Synchronisation with both systems shall be maintained in parallel by the UE.

Additionally, specific parameter configuration of the System Information Broadcasting (SIB) messaging is required. These messages provide the UE with the basic access stratum and non-access stratum information, which are needed for its operation within the SDMB system. The basic control and synchronisation of this function, which otherwise resembles the UMTS RAN procedure, is located in the SDMB RAN.

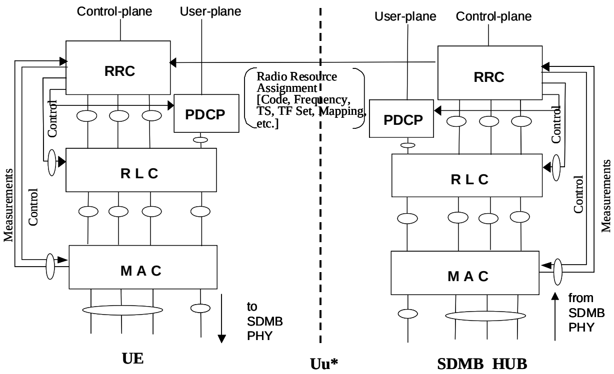

Fig. 1. SDMB access scheme

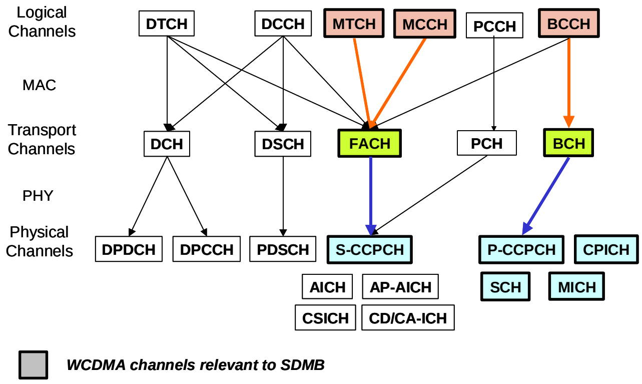

Fig. 2. WCDMA channels and their relevance to SDMB

User Service QoS Requirements

The SDMB system supports three types of p-t-m user services: streaming, download and Groupcast services. These services will be mapped into two traffic classes within the SDMB transport network, namely streaming and background, rendering the QoS attributes as described in [12]. The difference with the reported values therein is with respect to the information loss rate; within the SDMB RAN, higher loss rate shall be tolerated than in the UMTS RAN due to the intermittent UE connectivity. Therefore to provide the end user with adequate service quality, SDMB shall have to resort to error recovery techniques such as application-layer forward error correction (see for example [13] and [14]).

ACCESS SCHEME DEFINITION

As shown in Fig. 1, the SDMB access scheme follows closely the WCDMA access scheme, embracing two layers, the radio link layer (layer 2 of the radio interface) and part of the radio network layer (layer 3 of the radio interface). The layer 2 consists of three sub-layers, the MAC, the RLC and the PDCP sub-layers. The first two exist in both the user-plane and the control-plane, whereas PDCP is only relevant to the user-plane. The network layer is part of the control plane and is also organised in sub-layers, the main one being the Radio Resource Control (RRC) sub-layer.

SDMB Access Scheme Channels

The functionality of the SDMB radio interface layers is organized into the concept of channels, each one grouping a specific set of functions at the user and/or control planes. The SDMB set of channels, as shown in Fig. 2, is a subset of the WCDMA set of channels; only the downlink common channels are relevant given the unidirectional nature of the system and the p-t-m services it provides. The WCDMA logical channels relevant to SDMB are the MBMS point-to-multipoint Traffic Channel (MTCH), the MBMS point-to-multipoint Control Channel (MCCH), and the Broadcast Common Control Channel (BCCH). MTCH and MCCH are channels that have been introduced specifically for the support of MBMS, as described in [6]. The BCCH carries fundamental signalling information in the SDMB RAN and its reception is mandatory for all terminals.

The SDMB-relevant WCDMA transport channels are the Forward Access Transport Channel (FACH) and the Broadcast Channel (BCH). Their use in SDMB does not introduce additional considerations. As for the WCDMA physical channels, only the Primary Common Control Physical Channel (P-CCPCH), the Secondary Common Control Physical Channel (S-CCPCH), the Synchronisation Channel (SCH), the Common Pilot Channel (CPICH), and the MBMS Notification Indicator Channel (MICH) are applicable in SDMB. The MICH is a new MBMS specific Paging Indicator Channel (PICH) used to send the MBMS notification indicators, thus enabling the UE to be informed about imminent or ongoing transfers [6].

SDMB Radio Link Layer Definition

MAC Sub-layer

The MAC sub-layer provides logical channels to the RLC sub-layer and maps the BCCH and MTCH/MCCH logical channels into BCH and FACH transport channels, respectively. MAC has the overall responsibility of controlling the communications over the WCDMA transport channels provided by the physical layer. In order to be able to share the capacity of the transport channels amongst the users, the MAC protocol uses transport blocks as units of transmission. MAC is responsible for selecting an appropriate transport format (TF) for BCH and FACH, which depends on the instantaneous source rate of the respective logical channels mapped to them. On FACHs, MAC provides addressing of user equipment and scheduling of packet data units (PDUs). MAC also collects statistical information about the traffic, which is used by the RRC layer. These MAC measurements include local measurements such as buffer occupancy, in terms of both mean value and variance.

Fig. 3 shows the MAC architecture within SDMB RAN. Given the unidirectional nature of SDMB, it includes a subset of the MAC logical entities defined for T-UMTS [6][7]:

- ***MAC-b*** – the entity responsible for the BCH
- ***MAC-m*** – the entity defined to support MBMS user-plane and control-plane specific functions. It is responsible for the mapping of the two logical channels considered for p-t-m transmission, i.e., MCCH and MTCH, onto FACH

The MAC Control Service Access Point (SAP) is used to transfer Control information to each MAC entity. In the SDMB RAN, there is one MAC entity (MAC-b and MAC-m) for each spot. There is also one MAC entity (MAC-b and MAC-m) for each UE. Note that the dual-mode UE, however, will feature the full set of MAC functionalities (depending on its class) that will allow it to receive the point-to-point (p-t-p) services via the terrestrial network.

On the SDMB RAN side, the MAC-m entity transmits MBMS data and control information over FACH. It is responsible for the following functions:

- ***Addition of MBMS-ID:*** The MBMS-ID field in the MAC header is used to distinguish between MBMS services.
- ***TCTF Multiplexing:*** This function handles the insertion of the Target Channel Type Field (TCTF) field in the MAC header and also the respective mapping between MTCH and MCCH onto FACH. The TCTF field indicates which type of logical channel (i.e. MTCH and MCCH) is used.
- ***Scheduling – Priority Handling:*** This function manages common transport resources between MBMS data and control information according to their priority.
- ***TFC selection:*** Transport format combination selection is done for FACH mapped to MTCH and MCCH.

On the UE side, the MAC-m entity receives MBMS data and control information over FACH. It is responsible for the following functions:

- ***Reading of MBMS-ID:*** The MBMS-ID identifies data to a specific MBMS service.
- ***TCTF DEMUX:*** This function handles detection and deletion of the TCTF field in the MAC header, and also the respective mapping between MTCH and MCCH onto FACH. The TCTF field indicates which type of logical channel (i.e. MTCH and MCCH) is used.

RLC Sub-layer

The RLC sub-layer provides the data transfer service to higher layer PDUs as RLC Service Data Units (SDUs). On the control plane, the RRC layer uses the RLC services, known as the Signalling Radio Bearers (SRBs), for signalling transport. On the user plane, the RLC services are known as the Radio Bearers (RBs) only if the PDCP is not used; otherwise the RB service is provided by PDCP.

Fig. 4 depicts the SDMB RLC sub-layer architecture, which includes a subset of the entities defined in [8]. Since there is no return link directly via the satellite in SDMB system and data retransmissions are not supported at the radio link layer, only the transparent mode (TM), and unacknowledged mode (UM) RLC entities are relevant. Note that the TM- and UM-RLC entities are defined to be unidirectional, i.e. they can be configured to act either only as transmitting or as receiving entities. Within SDMB, since data flow is from SDMB RAN to the UEs, the transmitting entities only reside at the SDMB RAN side, while at the UE side, the TM- and UM-RLC entities act only as receivers. In the SDMB RAN, there is one RLC entity for each MBMS service in each cell, while in the UE side, there is one RLC entity for each MBMS service. Each RLC entity exchanges data PDUs via the logical channels. Note that a dual-mode SDMB terminal shall have the full RLC functionality for interfacing with T-UMTS and accessing services not provided by SDMB.

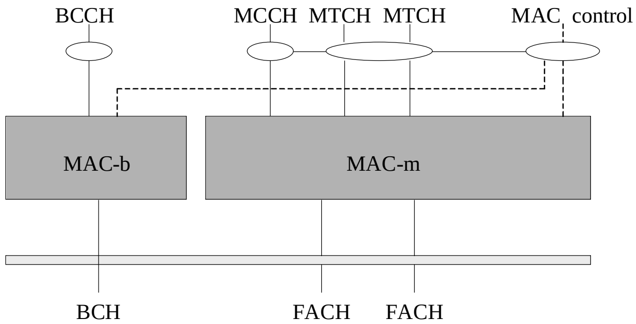

Fig. 3. SDMB MAC architecture

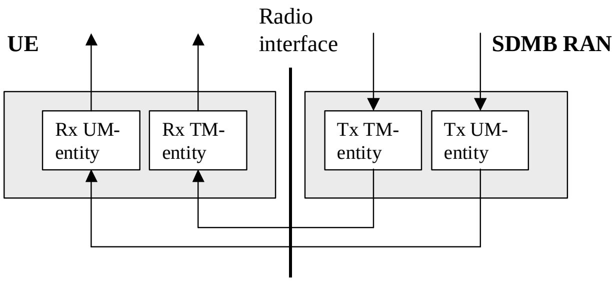

Fig. 4. Overview model of the SDMB RLC sub-layer

The only logical channel making use of the RLC TM service is the BCCH. In RLC TM, the transmitting entity in SDMB RAN receives RLC SDUs from upper layers through the TM-SAP and these are forwarded to the MAC layer on the BCCH logical channel. The RLC SDUs must be a multiple of one of the valid TM data (TMD) PDU lengths. On the receiving part, the UE TM-RLC entity collects the TMD PDUs from the lower layers and forwards them to the upper layers via the TM-SAP. Hence the only function provided in this mode is the transfer of user data.

The logical channels making use of the RLC UM service are the MCCH and MTCH. Contrary to the TM-RLC PDU, an UMD PDU in the transmitting entity may contain segmented and/or concatenated RLC SDUs. Padding may also be applied to impose a valid length on the PDU. Moreover, length indicators are used to define boundaries between RLC SDUs within the same PDU, in case of concatenation. Similar indicators dictate the use or not of padding within the UMD PDU. On the receiving part, the UE UM-RLC entity removes the RLC headers added at the transmitting side, and reassembles RLC PDUs into SDUs, if the respective features (segmentation/concatenation) have been activated at the transmitting side. The UM SAP at the UE side is used for passing the RLC SDUs to the upper layers. Hence the functions provided by the unacknowledged mode are segmentation and reassembly, concatenation, padding, transfer of user data, sequence number check, and SDU Discard. Note that as compared to p-t-p service, ciphering is not performed by RLC UM since it has been the working assumption that encryption for MBMS is performed end-to-end, and not at either the Radio or the Core Network level [6].

PDCP Sub-layer

The PDCP sub-layer exists only in the user plane and is defined for the PS domain only. Fig. 5 shows the model of the PDCP within the SDMB radio interface protocol architecture, which is a subset of the ones defined in [9] for T-UMTS. As can be seen, the PDCP resides in both the SDMB RAN and the UE side. In the SDMB RAN side, there is one PDCP entity per cell supporting SDMB service. In the UE side, there is one PDCP for each SDMB service.

The PDCP entity at the SDMB RAN side performs header compression upon reception of a PDCP SDU from upper layers and submits the PDCP PDU to the UM-RLC entities, while the PDCP entity at the UE side performs header decompression upon receiving the PDCP PDU from the UM-RLC entities and delivers the PDCP SDU to the upper layers. This structure is in accordance with the SDMB architecture, with the transmitting entities residing at the SDMB RAN and the receiving entities at the UE side only. Every PDCP entity uses zero, one or several different header compression protocol types. The PDCP sub-layer is configured by the RRC through the PDCP-C-SAP.

The PDCP contains compression methods needed for better spectral efficiency for delivery of IP packets over the radio interface and since SDMB traffic is encapsulated in IP datagrams, the PDCP sub-layer has an essential role in SDMB service provision. The PDCP sub-layer may operate with the RObust Header Compression (ROHC) protocol [10], which is the only header compression protocol supported by 3GPP that is capable of compressing the RTP header used in multimedia streaming applications. There are three modes of operation specified for ROHC, i.e. Unidirectional (U-mode), Bidirectional Optimistic (O-mode), and Bidirectional Reliable mode (R-mode). The U-mode is the only mode of operation supported in SDMB since the packets are sent only in one direction from the SDMB RAN to the UE, and there is no return path from the decompressor (located at the UE) to the compressor (located at the SDMB RAN). This mode of operation is also the current option adopted within 3GPP MBMS [6] since the other two modes require feedback links. With the U-mode, transitions between compressor states are performed only on account of periodic timeouts and irregularities in the header field change patterns in the compressed packet stream. Due to the periodic refreshes and the lack of feedback for initiation of error recovery, the compression in this mode will be less efficient and

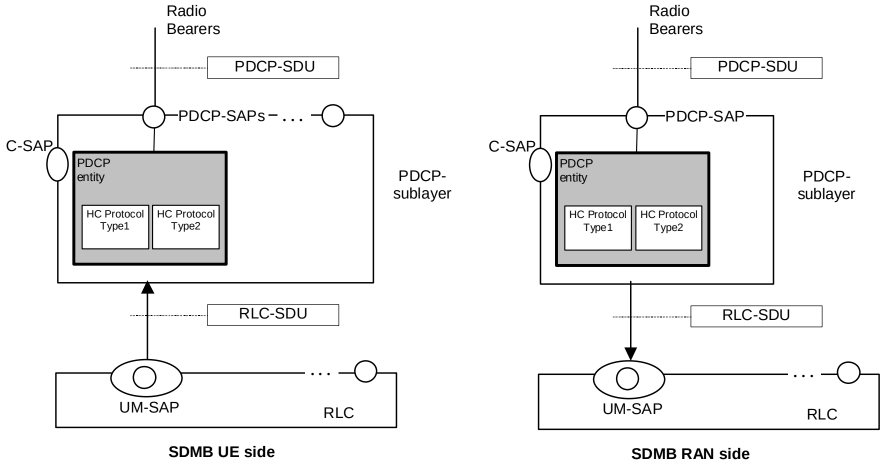

Fig. 5. SDMB PDCP structure

have a slightly higher probability of loss propagation compared to the bi-directional modes [10].

Besides providing header compression and decompression of IP data streams, PDCP also conveys data between users of PDCP services. The support for loss-less Serving Radio Network Subsystem (SRNS) relocation (normally a function of PDCP for p-t-p transmission within UTRAN) is not required since SRNS relocation is not applicable within SDMB and also due to the fact that a MBMS RAB cannot be relocated due to its multicasting characteristics.

SDMB RRC Definition

The functions of the RRC layer are again a subset of the full T-UMTS RRC [11] functionality. These include the broadcast of information related to the non-access stratum layers and access stratum layers, exchanged between UE and the Core Network and between the SDMB RAN and UE, respectively; the establishment, reconfiguration and release of Radio Bearers; and the initial spot selection. The RRC sub-layer also implements algorithms for power allocation for common channels, radio admission control and radio resource allocation control under the radio resource management (RRM) tasks. The RRC functional entities, which are applicable to SDMB as shown in Fig. 6, are:

- ***Broadcast Control Function Entity (BCFE):*** for delivering system broadcast information,
- ***Paging and Notification Function Entity (PNFE):*** for notifying UEs of system information modification. This can be useful for informing UEs, which receive SDMB service on a MTCH/FACH and are not capable of decoding simultaneously the BCCH/BCH/P-CCPCH.

SDMB RRC States

Fig. 7 depicts an overview of the state transitions of the SDMB dual-mode terminal. After SDMB activation, the UE stays in SDMB Idle Mode. In the SDMB Idle Mode, the UE shall select and monitor the indicated MICH of the spot, monitor the relevant System Information, perform necessary measurements for the spot reselection evaluation procedure, and subsequently execute the spot reselection evaluation process based on UE internal triggers, and when information on the BCCH used for the spot reselection evaluation procedure has been modified. The SDMB RAN has no information of its own about the individual Idle Mode UEs and it can only address all UEs in a cell or all UEs monitoring a specific paging occasion. Note that in this mode, the UE is also ready to receive any SDMB traffic.

The SDMB Disabled Mode is entered when the UMTS/GSM stack is activated. This mode corresponds to no SDMB RRC activity in the UE since the current assumption of the SDMB dual-mode terminal architecture is that there is a single reception chain to receive both UMTS/GSM and SDMB signals and therefore, simultaneous reception of these signals is not possible. This ultimately implies that the satellite signal reception is not only affected by propagation impairments, but is also impossible whenever terrestrial reception occurs, since the UMTS/GSM chain is considered to be the priority chain. The events which cause the transition to the SDMB Disabled Mode includes signalling associated with the terrestrial network such as listening to paging occasions and performing neighbouring cell measurements, as well as the use of the terrestrial network to make a call, i.e. establishing an RRC Connection with the UTRAN. After performing these events, the UE reverts to the SDMB Idle Mode since the default mode of operation is the SDMB.

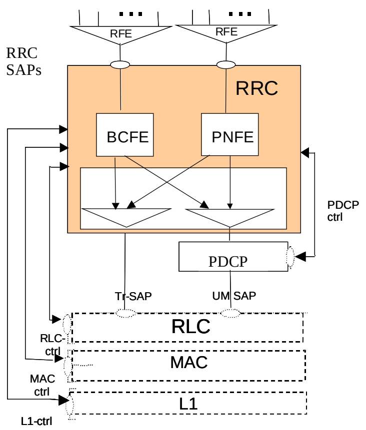

Fig. 6. SDMB RRC entities

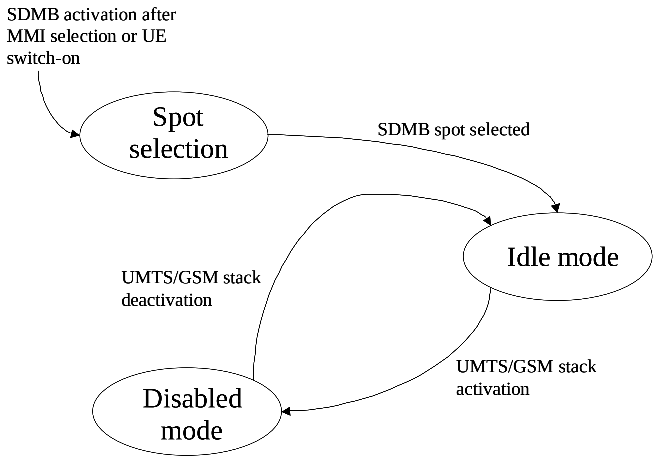

Fig. 7. SDMB RRC state diagram

PROCEDURES FOR THE SUPPORT OF MBMS WITHIN THE SDMB RAN

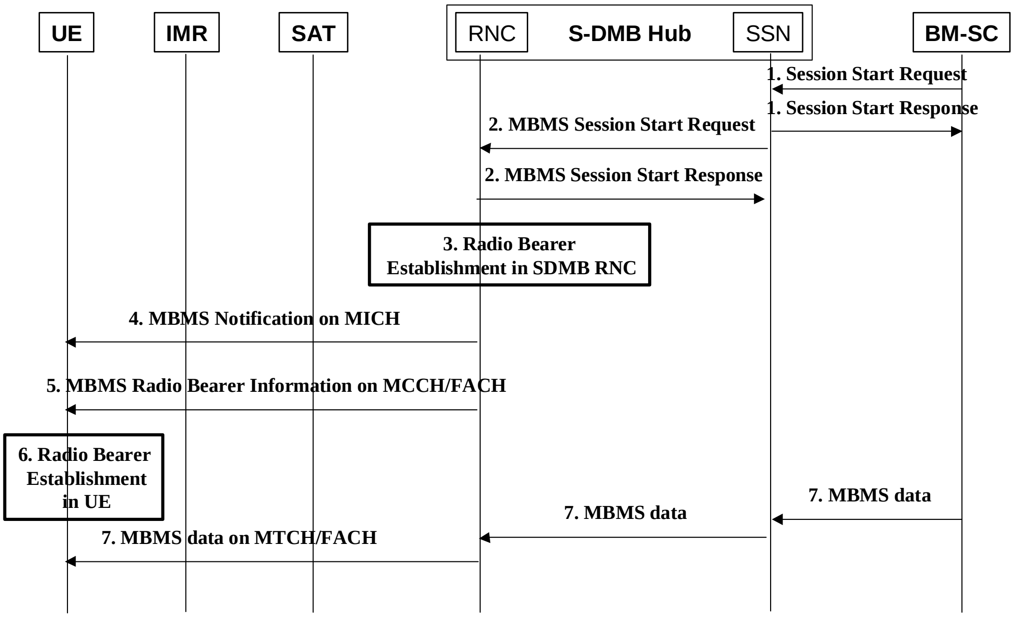

Fig. 8. MBMS Notification, RB Setup and Data Transfer procedure

In this section, the executed procedures within the SDMB RAN for the delivery of MBMS services are described. Given that the services considered in SDMB are push-type in nature, only a subset of those MBMS procedures described in [6] is pertinent to SDMB. Due to space limitation of this paper, the procedures associated with the termination of MBMS session, which leads to the release of bearer plane resources in the network, are not described herein

Fig. 8 summarizes the three main procedures for the delivery of the MBMS services within SDMB RAN –notification, radio bearer establishment and data transfer– triggered by the session-start procedure of the Broadcast Multicast Service Center (BM-SC). It is assumed that the UE is already logged onto the P-CCPCH, and is able to receive the MBMS system information transmitted on the BCCH logical channel, which carries the MCCH schedule information as well as the radio bearer configuration for MCCH reception.

1. The BM-SC initiates the MBMS Session Start procedure to notify the impending start of the transmission and to provide the session attributes (QoS, estimated session duration…) so that all the necessary bearer resources in the network can be activated for the transfer of MBMS data. The reception of the Session Start request in the registered SDMB support node (SSN)[2] changes the state attribute of its MBMS bearer context[3] to 'Active' mode and the SSN sends back a Session Start Response message to the BM-SC.
2. The SSN sends an MBMS Session Start Request message including the MBMS Service ID (which identifies all MBMS services that are potentially available) and the session attributes to the SDMB Radio Network Controller (RNC). The arrival of the Session Start message will create the MBMS bearer context for the specific service in the SDMB RAN, if one has not been created. It also provides the MBMS lu Data Bearer Establishment functionality. The SDMB RNC then responds with an MBMS Session Start Response to the SSN. In case the RNC does not have the required radio resources, it will notify the SSN accordingly.
3. The SDMB RNC configures the MTCH for the transfer of MBMS data to the interested UEs. It also updates the MCCH (MBMS Radio Bearer Information). Note that the MBMS Service Information as specified in [6] is not required since the MBMS bearers over SDMB RAN are p-t-m only.
4. The SDMB RAN sends a MBMS notification on the MICH to inform the UEs of an upcoming change in the critical MCCH information, namely the MBMS Radio Bearer Information. Note that in-band notification may be used instead/as well to notify users that are already tuned on a MTCH receiving some SDMB services.
5. Upon the terminal wakeup from Discontinuous Reception (DRX) conditions, the UEs evaluate the MBMS Notification Indicator (NI) corresponding to services of their interest and if set, read the MCCH at pre-defined time(s), i.e. at the beginning of the next modification period (an integer multiple of the repetition period, which in turn is defined as the periodic transmission of the entire MCCH information), to acquire the MBMS Radio

[2] The SSN is a simplified version of the terrestrial's SGSN and GGSN, which interconnects the BM-SC to a standard RNC [3].
[3] The MBMS bearer context contains all information describing a particular MBMS bearer service and is created in each node involved in the delivery of the MBMS data [1].

Bearer Information. The MBMS Radio Bearer Information includes the MBMS Service ID, logical channel, transport channel and physical channel information per MBMS service.

6. With this information, the UEs set up the MBMS radio bearer (MTCH/FACH/S-CCPCH) and create the MBMS context on the UE side.
7. The data transfer phase may then begin and MBMS data can be delivered to the UEs.

Note that the signalling flows between the SSN and the RNC are internal to the hub.

MBMS Procedures Not Relevant To SDMB

Overall, it can be seen that the following procedures as specified in [6] are not required in SDMB:

- ***Joining:*** With no satellite uplink available this procedure, by which a subscriber joins a multicast group by indicating to the network that he/she is willing to receive multicast mode data of a specific MBMS bearer service [1], becomes irrelevant to the SDMB RAN.
- ***Counting/Recounting:*** This procedure is used in terrestrial radio access networks to determine the most optimum MBMS transmission mode, namely p-t-p versus p-t-m bearer, taking into account the number of UEs expected to receive the service. With only p-t-m bearers being employed for the MBMS service in SDMB, the counting/recounting procedure is not relevant to SDMB.
- ***RNC Registration/Deregistration:*** In T-UMTS, each Serving GPRS Support Node (SGSN) has under its control a number of RNCs. Those RNCs with users interested in a specific service have to register with the Core Network. Registration is performed on per-service basis and assumes awareness about the existence of PMM-connected UEs in the area under the RNC control, namely users who have established packet signalling connection with the network. In SDMB, there is one-to-one relation between SDMB RNC and SSN (the simplified SDMB Core Network) and, most importantly, the SDMB RAN does not maintain any connection with UEs.
- ***Channel Switching:*** As only p-t-m bearers are relevant to SDMB, channel switching between dedicated channel and common channel is not relevant.
- ***UE Linking/De-linking:*** The linking procedure is used to link a UE, which has joined the MBMS service, to an MBMS service context in the RNC (or to remove a specific UE from one or several MBMS service context in the RNC for the de-linking procedure) and is only applicable for UEs in PMM-CONNECTED mode [6]. With no PMM state defined in SDMB, this procedure is therefore not relevant to SDMB.
- ***Selective Combining:*** In T-UMTS, the UE may take advantage of MBMS transmissions in neighbouring cells belonging to the same MBMS service area and perform selective combining. Within the context of the mono-spot architecture defined for SDMB, this feature is not applicable to SDMB.

CONCLUSIONS

The SDMB system has been defined to complement mobile networks with broadcast and multicast capabilities for spectrum-efficient delivery of multimedia services on mobile devices in both outdoor and indoor environments, without introducing constraints on the user terminal or the consumer itself. The proposed system will pave the way for an effective satellite and terrestrial network convergence. In this paper, the access scheme requirements and the definition of the layers 2 and 3 of the SDMB access scheme have been presented. Its main features are the following:

- Maximum commonalities with the UTRA WCDMA FDD air interface. The 3GPP specifications have been the starting point for the access scheme definition. Adaptations and modifications to the satellite environment have been made where applicable.
- Given that the baseline architecture of the system is unidirectional, i.e. without a satellite return link, only the downlink direction of the WCDMA interface is of interest to SDMB.
- Due to the p-t-m nature of the services, only the subset of WCDMA functionality required for the support of common/ p-t-m channels is relevant to the SDMB access scheme.

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